Final Report

EAST-WEST LINE FAULTY TRAIN INCIDENT

25 SEPTEMBER 2024

TIB/RAI/CAS.014

Transport Safety Investigation Bureau
Ministry of Transport
Singapore

31 May 2025

<u>The Transport Safety Investigation Bureau of Singapore</u>

The Transport Safety Investigation Bureau (TSIB) is the air, marine and rail accidents and incidents investigation authority in Singapore. Its mission is to promote transport safety through the conduct of independent investigations into air, marine and rail accidents and incidents.

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ABBREVIATIONS

BDL	Braddell Station
CLE	Clementi Station
DVR	Dover Station
EWL	East-West Line
JUR	Jurong East Station
KCD	Kim Chuan Depot
LVR	Lavender Station
MEC	Maintenance Engineering Centre
NSL	North-South Line
OCC	Operations Control Centre
QUE	Queenstown Station
QUE-X	Queenstown Crossover
RDH	Redhill Station
RSC	Rolling Stock Controller
SM	Station Manager
TLK	Tuas Link Station
TWD	Tuas West Depot
UPD	Ulu Pandan Depot

SYNOPSIS

On 25 September 2024, a high axle box temperature reading was registered by the Hot Axle Box Detection System (for monitoring the temperature of the axle boxes of trains) when the East-West Line passenger train T310 passed by Lavender Station. Subsequently, in response to reports of smoke and burning smell from T310, the rail operator's Operations Control Centre ordered the train to be withdrawn to Ulu Pandan Depot (UPD). When the train was entering UPD, it came to a stop at the entrance track. Four wheels of T310's Car 2065's front bogie had come off the rails. The axle box of Car 2065's second axle was missing and later recovered near Dover Station. The track and trackside equipment along a stretch of some 2,550m of the track were damaged in this incident.

The Transport Safety Investigation Bureau of Singapore classified this occurrence as an incident.

1 FACTUAL INFORMATION

(Note: Diagrams are not to scale)

1.1 Sequence of events

1.1.1 At 0658 hours on 25 September 2024, the East-West Line (EWL) passenger train T310 departed Pasir Ris Station (PSR). Subsequently, following reports by the rail operator's staff of smoke and burning smell from T310, the rail operator's Operations Control Centre (OCC) in Kim Chuan Depot (KCD) ordered the train to be withdrawn to Ulu Pandan Depot (UPD). When the train was entering UPD, it came to a stop at the entrance track of UPD at 0920 hours.

1.1.2 The table below summarises the sequence of events.

Time (hours)	Event
0658	T310 departed PSR westbound (WB) for Tuas Link Station[1] (TLK).
0723	A sensor of the Hot Axle Box Detection System (hereinafter referred to as Hotbox system) located on the WB track near Lavender Station (LVR) detected that one of T310's axle boxes had reached 118°C and generated a Level 1 warning at the Hotbox console at the Maintenance Engineering Centre (MEC) located at KCD. However, the Hotbox system could not identify the train and generated a label of Null identity (ID) for the train. (More on Hotbox system in paragraph 1.6) The rolling stock controller (RSC) monitoring the Hotbox system noted the Level 1 warning icon and the Null ID. He believed the Level 1 warning associated with the Null ID was a false warning and took no follow-up action.
0822	T310 arrived at the TLK WB platform.
0825	T310 departed TLK for PSR and about 5 minutes later, some operations staff reported to the OCC of a burning smell.
0834	As instructed by the OCC, the station manager (SM) of TLK checked the track of WB platform and reported to the OCC

[1] PSR is EWL's east end station for service turnaround to the west and TLK the west end station for service turnaround to the east.

Time (hours)	Event
	that there was no burning smell.
0850	As instructed by the OCC, the SM of Clementi Station (CLE), boarded T310 to carry out an inspection when the train arrived at CLE.
0852	The CLE SM reported to the OCC that there was a burning smell inside T310.
0853	The OCC ordered the detrainment of T310 and its withdrawal to UPD. The CLE SM left the train after passengers had disembarked. For the withdrawal to UPD from CLE, T310 needed to continue eastward passing four stations (viz. Dover, Buona Vista, Commonwealth and Queenstown) to the nearest turnaround point, viz. the Queenstown crossover (QUE-X) located between Queenstown Station (QUE) and Redhill Station (RDH).
0904	As instructed by the OCC, the SM of Dover Station (DVR), which was the next station after CLE, boarded T310 to check for burning smell and smoke when the train arrived at DVR. He noticed a burning smell inside T310 but did not notice any smoke. He reported to the OCC accordingly. The T310 TC did not notice any fault indications at the driving cab. The DVR SM remained on board T310 to monitor the situation.
0908	T310 crossed over from the EB track to the WB track at QUE-X and moved westward.
0916	Traction power tripped between DVR and CLE WB but T310 was able to coast into CLE. The T310 TC and DVR SM did not notice any burning smell nor smoke during the coasting.
0919	Traction power was restored. The DVR SM alighted at CLE before T310 continued for UPD.
0920	Traction power tripped again and T310 stalled on the entrance track of UPD. The OCC was unable to restore the traction power.

1.1.3 At 0928 hours, the OCC activated a recovery team to rescue T310. Four wheels of T310's Car 2065's front bogie were found to have come off the rails (see **Figure 1**). The axle box of the second axle was missing and later recovered near DVR (more on axle box in paragraph 1.5.2).

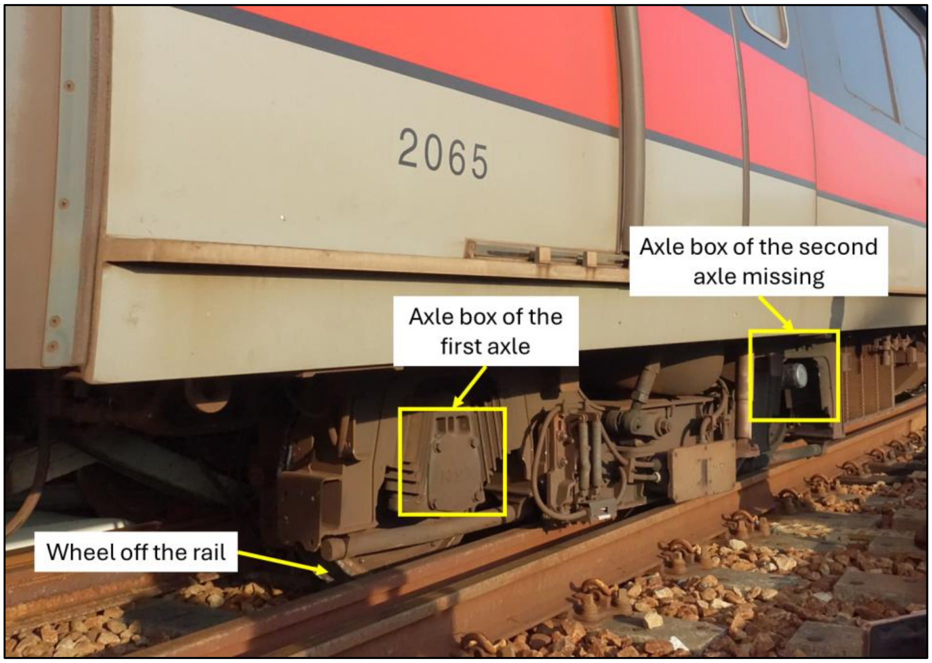

Figure 1: Axle box of the second axle was missing

1.2 Injuries to persons

1.2.1 No one was injured in the incident.

1.3 Damage

1.3.1 The missing axle box from the second axle of Car 2065 was axle box 19 on T310 (more on axle box numbering in paragraph 1.5.1).

1.3.2 **Figure 2** shows a diagram of an axle box and its chevron springs (each made up of 5 metal plates, bonded together by rubber material) and **Figure 3** shows the damage to axle box 19 and its chevron springs. The temperature stickers on axle box 19 (more on temperature sticker in paragraph 1.5.2.2), as well as the grease in the bearings of axle box 19, were burnt off.

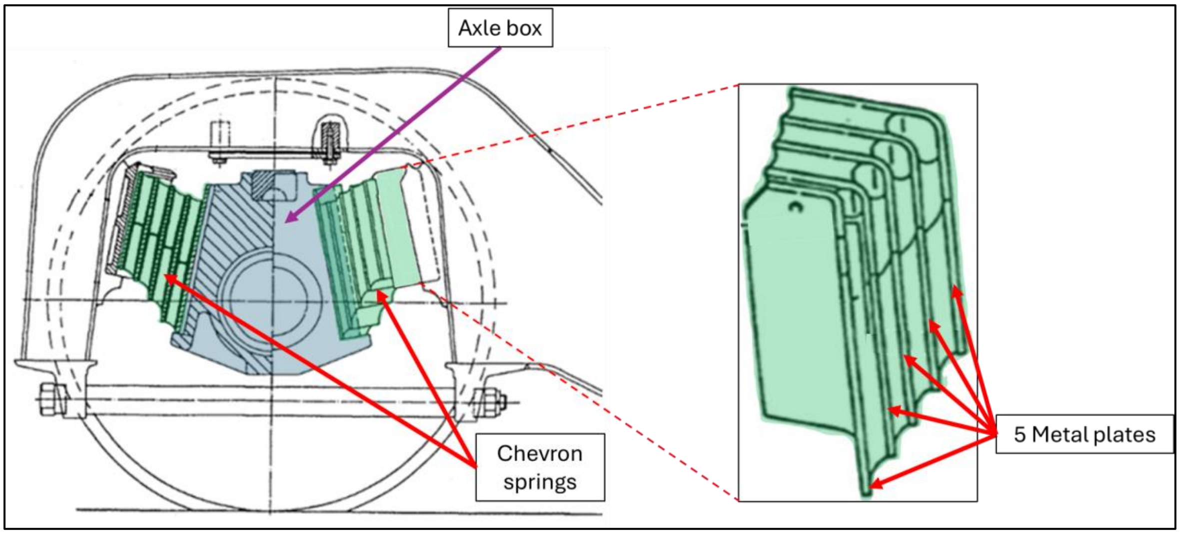

Figure 2: Diagram of an axle box (left) and its chevron springs (right)

		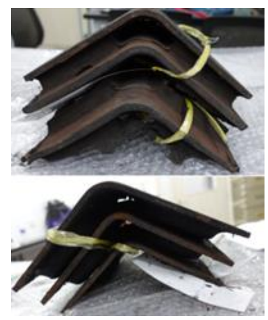
Front side	Inner side	Damaged chevron springs

Figure 3: Damage to front/inner side of axle box 19 and its chevron springs

1.3.3 The track and trackside equipment (e.g. point machines, power cables, running rail fasteners and third rails) along a stretch of some 2,550 m of the WB track between Jurong East Station (JUR) and DVR were damaged in this incident. **Figure 4** shows the locations where the debris of the axle box and chevron springs were found. All the metal plates of axle box 19's chevron springs, except L4 on the left-side chevron spring and R2 on the right-side chevron spring (as shaded in **Figure 5**), were recovered.

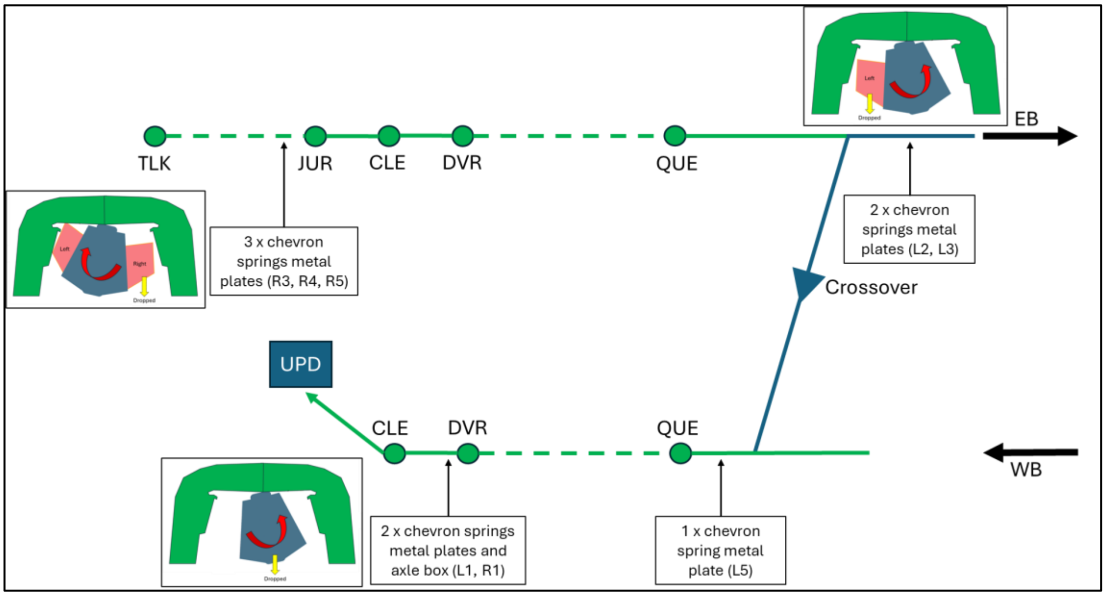

Figure 4: Locations where the debris pieces were found

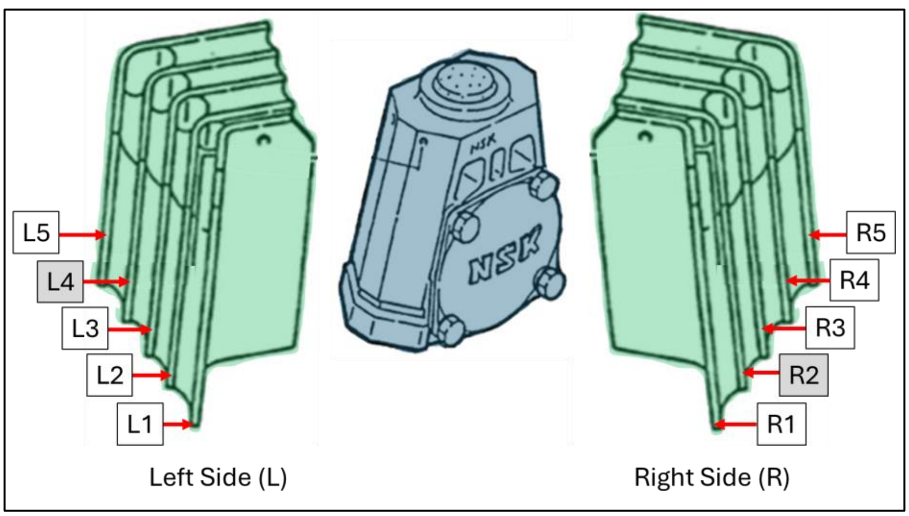

Figure 5: All metal plates of the chevron springs except L4 and R2 were recovered

1.4 Personnel information

1.4.1 The table below shows the length of service with the rail operator of the personnel involved as well as their experience.

Personnel	Age	Length of service at time of incident	Experience in the role
TC 310	27	1 year 4 months	10 months
RSC	33	1 year 5 months	1 year 5 months

1.5 Train information

1.5.1 T310 belonged to a fleet of 66 trains that had been in use since 1987. Each of these trains has six cars. Car 2065 was one of the two cars in the middle of T310. The axle box that failed was axle box 19 on Car 2065 (see **Figure 6**).

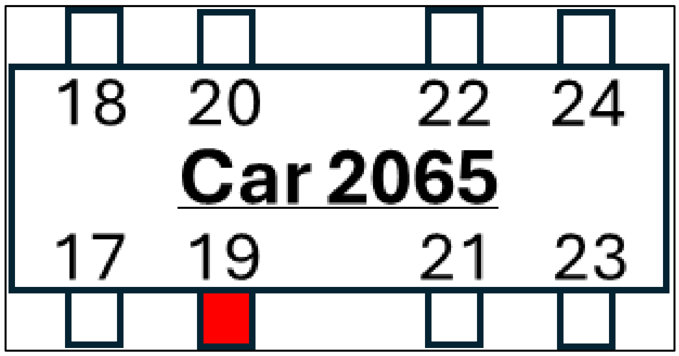

Figure 6: Numbering of axle boxes on Car 2065

1.5.2 Axle boxes and chevron springs

1.5.2.1 Each train car has two bogies; each bogie has two axles; and each axle has an axle box on each end of the axle, i.e. a total of eight axle boxes per train car. Each axle end rotates on greased bearings which are sealed in each axle box. Axle boxes are used to transfer the load of the train car to the wheels.

1.5.2.2 On its own initiative, the rail operator affixed on each axle box two temperature stickers (see **Figure 7**) that will irreversibly blacken if the axle box exceeds predefined temperatures (82°C and 93°C). The rail operator's experience was that the typical operating temperature range for axle boxes was 30°C – 65°C.

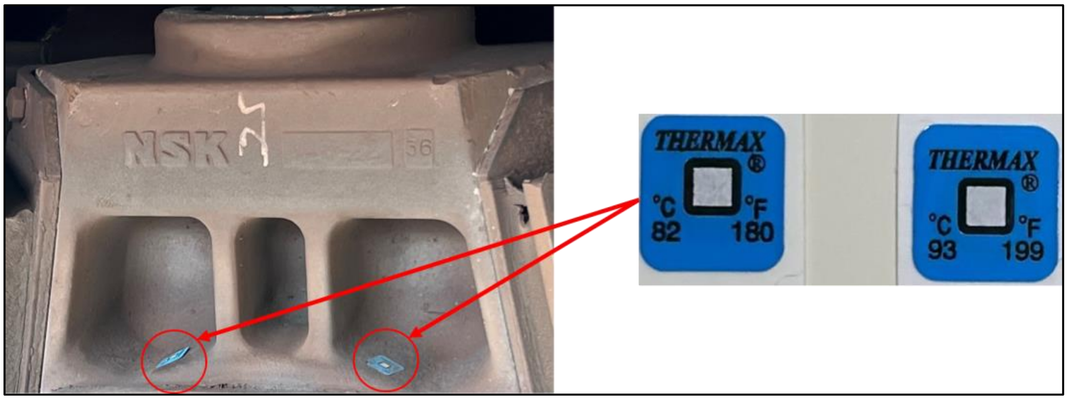

Figure 7: Temperature stickers (not on incident train)

1.5.2.3 Bogie frames are mounted on axle boxes via chevron springs, which are the primary suspension of the train (see **Figure 8**). The chevron springs dampen vibrations and impact forces experienced by the train. They consist of metal plates bonded together by rubber material.

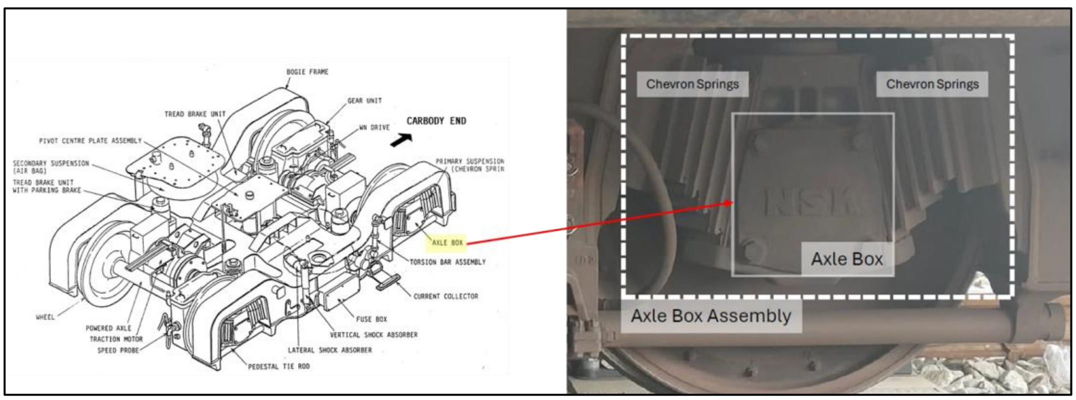

Figure 8: Axle box assembly on the bogie

1.5.2.4 The functionality of the chevron springs is checked by measuring the clearance gap between the top of the axle box and the bogie frame (the check is hereinafter referred to as the chevron spring clearance gap check - see **Figure 9**). The acceptable range for the gap is 27 – 30 mm. This clearance gap check is to determine whether a train car is drooping because of the weakening of one or more of the chevron springs.

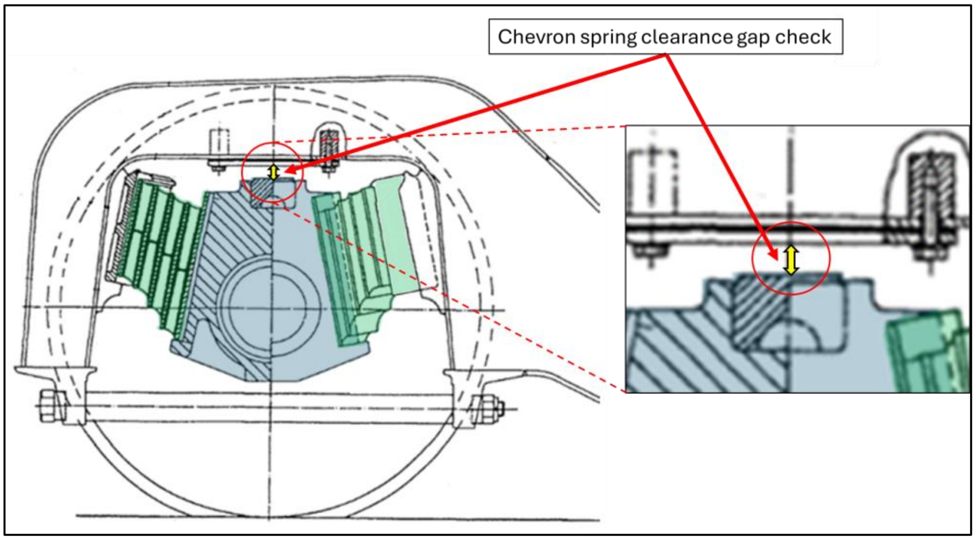

Figure 9: Chevron spring clearance gap check

1.5.2.5 The 3-weekly chevron spring clearance gap check on T310 was last carried out on 10 September 2024. According to T310's maintenance records, the clearance was within the acceptable range.

1.5.3 Maintenance of axle boxes and chevron springs

1.5.3.1 The rail operator's maintenance schedule for axle boxes and chevron springs comprised the following:

- [Short interval] 3-weekly preventive maintenance
- [Medium interval] 6-monthly preventive maintenance
- [Long interval] Overhaul at 500,000 km interval

1.5.3.2 The TSIB investigation team noticed some differences between the train manufacturer's recommended maintenance practices and the rail operator's actual maintenance practices, as follows:

(a) The rail operator performed chevron spring clearance gap check at a frequency higher than that recommended by the train manufacturer, 3-weekly instead of 6-monthly.

(b) The train manufacturer recommends a grease leakage check[2] to be performed 1-weekly, but the rail operator does it 3-weekly. The train manufacturer also recommends a grease leakage check to be performed 3-monthly, but the rail operator does it 6-monthly.

(c) The rail operator performs an axle box visual check 3-weekly although the train manufacturer does not require such a check. On the other hand, the train manufacturer recommends detailed axle box visual check to be performed 3-monthly, but the rail operator does it 6-monthly. It is to be noted that the detailed axle box visual check includes visual inspections of hexagon bolts, tab washers and self-locking nuts of the axle box, which are not covered by the rail operator's 3-weekly axle box visual check.

(d) The train manufacturer recommends that overhauls be performed 2-yearly, but the rail operator carries out overhauls at 500,000 km interval (equivalent to about 3.3-yearly based on a train usage of about 150,000 km per year)[3].

1.5.3.3 The maintenance practices in paragraphs 1.5.3.2 (a)-(d) above had been in place since trains started operations in 1987. The rail operator does not have records that could explain the merits of its maintenance practices as compared with those recommended by the train manufacturer. The TSIB investigation team does note, from data shared by the rail operator, that the rail operator's trains of the same model as T310 had, by the time of this incident, undergone some 8 to 10 overhauls since the start of train operations in 1987, at the 500,000 km interval. The rail operator had indicated that, while overhaul was kept at 500,000 km, it had not encountered problems with the axle boxes (including bearings) and it had been satisfied with the reliability performance of the axle boxes and bearings.

1.5.4 Waiver approval system for extending train overhaul interval

1.5.4.1 The rail operator's train maintenance schedule requires its train to undergo overhaul at 500,000 km interval. At times, the rail operator may only be able to carry out overhaul after the train has accumulated a mileage of more than 500,000 km. To cater to such contingencies, the rail operator has a waiver

[2] Grease leakage is checked for by visual inspections.

[3] The rail operator has also a waiver approval system to allow the overhaul interval to be extended ad hoc beyond 500,000 km (more on overhaul interval extension in paragraph 1.5.4).

approval system to permit such exceedance of the overhaul interval. The waiver approval system allows a 10% extension of the 500,000 km overhaul interval (i.e. overhaul interval extension to 550,000 km, without the need for a technical assessment or justification. Extensions up to 15%, 25% and beyond 25% (i.e. overhaul interval extension to 575,000 km, 625,000 km and beyond 625,000 km respectively) will have to be evaluated and approved by senior management of the rail operator.

1.5.4.2 According to the rail operator, this waiver approval system did not need to be endorsed by the rail authority. Nevertheless, the rail authority was aware of this waiver approval system of the rail operator.

1.5.4.3 At the time of the incident, T310 had operated 690,000 km, beyond the 500,000 km interval, since the last overhaul in 2018. The rail operator was able to furnish records of approval granted to extensions beyond 10% up to 15%, as well as for the extension beyond 25%. According to the rail operator, it had assessed the reliability and condition of the train, based on the best available information at the time. However, these assessments of the two extensions were omitted in the waiver approval system's record. The rail operator was not able to furnish any record of request, assessment or approval for extension beyond 15% up to 25%.

1.6 Hotbox system

1.6.1 In 2014, the rail operator installed a Hotbox system for monitoring the temperature of axle boxes of trains during operation. The Hotbox system was an initiative of the rail operator. The rail authority did not require the rail operator to have such a system.

1.6.2 One set each of infrared sensor and radio frequency identification (RFID) sensor (see **Figure 10**) was installed on trackside at LVR WB track on the EWL and at Braddell Station (BDL) southbound (SB) track on the North-South Line (NSL). Four RFID tags are installed on each train, two on either side of the front car and two on either side of the rear car. The trackside RFID sensor will identify the train and provide an ID number to the Hotbox console in the MEC.

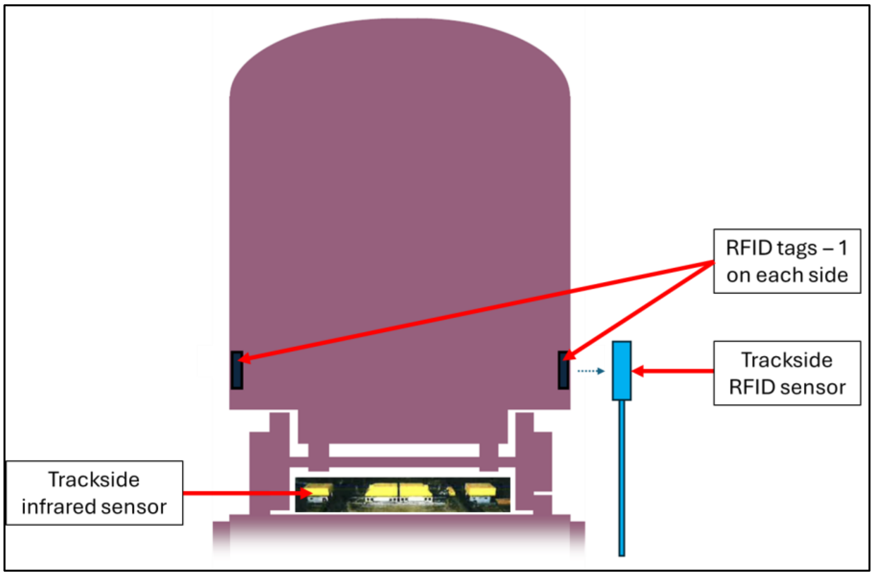

Figure 10: Hotbox system

1.6.3 The trackside infrared sensor measures the temperature of each axle box when a train passes by. When the temperature of an axle box is detected to have exceeded a predefined value, the Hotbox system generates a warning, which is displayed at the Hotbox console in the MEC. The rail operator's standard operating procedure for the Hotbox system requires a rolling stock controller (RSC) at the MEC to monitor the Hotbox system and take follow-up actions in response to the warning.

1.6.4 For an axle box temperature exceeding 90°C, a Level 1 warning with a red round icon will be displayed (see **Figure 11**). The RSC will inform the OCC so that the OCC will order the immediate withdrawal of the train to a depot. The RSC will also alert the train maintenance team so that the latter will inspect the train after it has been withdrawn to the depot.

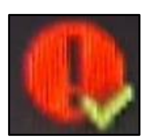

Figure 11: Red round icon

1.6.5 On the incident day, the RSC saw the Level 1 warning. However, the train ID was not detected, and the Hotbox console displayed a Null ID. The RSC believed that the warning was a false warning and did not take any follow-up action. The training received by RSCs did not address or provide guidance on actions to take when an RSC encountered Null ID indications.

1.6.6 The TSIB investigation team noted that there were instances of Null ID indications (i.e. train ID was not detected by the Hotbox system) as well as feedback from staff to the rail operator. However, the issue had not been resolved as Null ID indications were still being generated during operations.

1.7 Hotbox system temperature readings for T310

1.7.1 The TSIB investigation team reviewed the temperature readings for T310 collected by the Hotbox system since 10 September 2024 and prior to the incident on 25 September 2024 and noted that the readings were within the typical operating temperature range for axle boxes of 30°C – 65°C (see paragraph 1.5.2.2). The temperature of axle box 19 was slightly higher than the other axle boxes on T310. However, the highest temperature recorded (65°C) was within the typical operating temperature range of 30°C – 65°C and did not reach the trigger value for a Hotbox system warning and did not require any follow-up actions by the MEC or OCC.

2 ANALYSIS

The axle box 19 of Car 2065 had failed. This failure led to the four wheels of Car 2065's front bogie coming off the track.

The TSIB investigation team looked into the following:

(a) Axle box 19's failure sequence

(b) Maintenance and extension of overhaul interval

(c) Hotbox system's Null ID indication issue

(d) Detection of axle box temperature

(e) Industry cooperation

2.1 Axle box 19's failure sequence

2.1.1 Having considered the time sequence of events as described in paragraph 1.1.2 and the locations of the debris pieces shown in Figure 4 in paragraph 1.3.3, a probable failure sequence was as follows:

(a) Some time during the EB trip on the morning of 25 September 2024 axle box 19 and its chevron springs became heated[4]. The chevron springs became deteriorated (e.g. loss of the springs' elasticity, debonding and disintegration of the rubber material of the springs).

(b) By 0723 hours when T310 was around LVR area, axle box 19 reached a temperature of 118°C. This triggered a Level 1 warning of the Hotbox system. However, the Hotbox system generated a Null ID indication in connection with this high-temperature detection. The RSC believed the warning was a false warning and did not take further action.

(c) By around 0822 hours when T310 entered TLK, the heat experienced by the chevron springs was such as to cause some, or all, of the rubber material of the chevron springs to ignite, burn and progressively disintegrate.

[4] Paragraph 2.1.2 discusses whether the heat was generated within the axle box because of bearing seizure and the heat then propagated to the chevron springs, or whether a deterioration of the chevron springs resulted in the seizure of the axle box bearings and the heating of the axle box (and in turn the heating of the chevron springs).

(d) After T310's departure from TLK at 0825 hours for PSR, the intermittent or permanent bearing seizure, coupled with the train's EB movement (which entailed the axle box rotating clockwise), caused the chevron spring on the left-side of axle box 19 to be cornered against the bogie frame (see **Figure 12**). The metal plates R2 – R5 and the associated rubber material of the disintegrating chevron spring on the right-side progressively dropped on the EB track between JUR and QUE. (Metal plate R2 could not be found.)

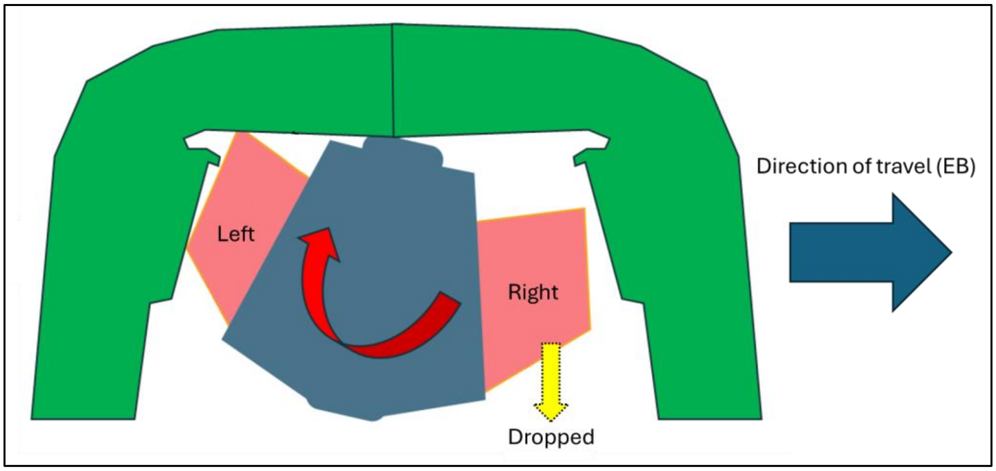

Figure 12: Left-side chevron spring cornered against bogie frame and right-side chevron spring dropped onto track *(Diagram courtesy of SGS Testing & Control Services Singapore Pte Ltd)*

(e) After T310 had changed direction at QUE-X, the train moved WB (which entailed the axle box rotating anti-clockwise). The chevron spring on the left-side was progressively released from being cornered against the bogie frame and the metal plates L2 – L5 and the associated rubber material of the disintegrating chevron spring on the left-side progressively dropped on the WB track around QUE-X and QUE (see **Figure 13**). (Metal plate L4 could not be found.)

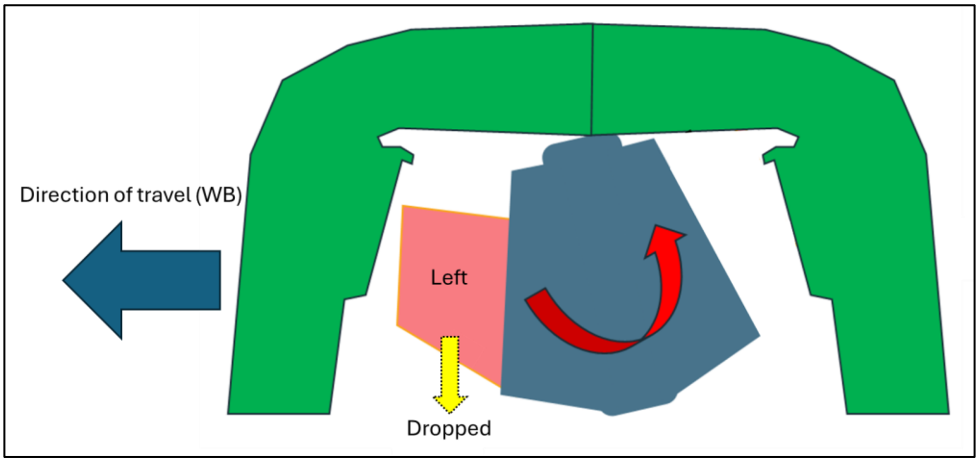

Figure 13: Left-side chevron spring detached

(f) Subsequently, axle box 19 became detached from the bogie and dropped on the WB track around DVR. Without the chevron springs and the axle box supporting the front bogie of Car 2065, the wheels of the front bogie eventually came off the rails.

2.1.2 The TSIB investigation team considered the following two possible scenarios as to whether the heat problem had originated within axle box 19 (i.e. the bearings) or from the chevron springs.

<u>Scenario A</u>

(a) This scenario considered that the bearings of axle box 19 had failed first. The resulting intermittent or permanent seizure of the bearings generated frictional forces as well as heat within axle box 19, and the heat propagated to the chevron springs. This scenario was propounded in view of the following:

(1) During the rail operator’s overhaul at 500,000 km interval, axle boxes are disassembled and the bearings degreased, cleaned, inspected and re-greased. These activities give the assurance that the axle box should be problem-free for another 500,000 km of usage.

(2) However, given that T310 had operated beyond the 500,000 km overhaul interval to 690,000 km without any additional maintenance requirements (e.g. inspections, modifications), the extent of

degradation of the grease is unknown[5]. It is doubtful if the bearings could remain in good condition beyond 500,000 km.

Scenario B

(b) This scenario considered that the root of the problem lay with the chevron springs. The rubber of the chevron springs had failed first, to the point that they could no longer perform the role as the primary suspension of the train. The bogie frame ended up sitting on axle box 19. Axle box 19 and the bearings within were subjected to dynamic forces as the train moved along (e.g. vertical impact forces from the bogie frame, vibrational forces, lateral forces arising from the train's turning or curving movement along the track). These forces stressed the bearings, and the bearings eventually failed. The resulting intermittent or permanent seizure of the bearings generated frictional forces as well as heat within axle box 19, and the heat propagated to the chevron springs and caused further damage to the chevron springs. This scenario was propounded in view of the following:

(1) The rubber material of the chevron springs can deteriorate over time.

(2) The 3-weekly chevron springs clearance gap check is to determine whether the chevron springs have weakened to the extent of allowing a train car to droop. It does not check that the quality of the chevron springs, in particular the rubber material, is being maintained. A chevron spring might have deteriorated over time beyond an acceptable level but the train car will not yet droop to an appreciable level because the train car is still being supported well by the other chevron springs of the train car.

2.1.3 The TSIB investigation team is unable to determine which scenario, A or B, is more likely, owing to the severity of the damage to axle box 19 and its chevron springs and despite extensive testing and examination of axle box 19 and chevron spring debris pieces.

[5] The grease in axle box 19's bearing had been burnt off. It was not possible to ascertain the quality of the grease in axle box 19's bearings and by extension whether the grease had degraded to a level that is considered beyond normal wear and tear. An examination of some of the bearings of other axle boxes on T310 did reveal various degrees of grease degradation, so it was more likely than not that the grease in axle box 19's bearings had also some degree of degradation, but it could not be ascertained if any such degradation was worse or better than the degradation of the grease in other axle boxes' bearings.

2.2 Maintenance and extension of overhaul interval

2.2.1 The maintenance practices and maintenance schedule for axle boxes had been in place since trains started operations in 1987. The TSIB investigation team has noted that, up to the time of the incident, the rail operator's experience was that the axle boxes had been problem-free when its trains were being overhauled as per the overhaul interval.

2.2.2 The rail operator has a waiver approval system to decide on extension of overhaul interval. The waiver approval system does not require the rail operator to consult the rail authority. The rail authority also does not require the rail operator to seek its approval for any extension of the overhaul interval.

2.2.3 As mentioned in paragraph 1.5.4.3, certain assessment records were either omitted in the waiver approval system's record or could not be furnished. While the lack of records on maintenance decisions may not have directly contributed to the incident, this incident highlights the importance of ensuring that records of evaluations and decisions made in an organisation's operations are documented.

2.2.4 The TSIB investigation team opines that extension to overhaul interval is a deviation from the maintenance schedule and may warrant closer scrutiny by the rail authority to ensure that the rationale for any such extension is sound.

2.3 Hotbox system's Null ID indication issue

2.3.1 As mentioned in paragraph 1.6.6, there were instances of Null ID indications presented to RSCs. According to information gathered from RSCs, the Null ID indications were treated as false warnings by RSCs. Repeated exposure by RSCs to false warnings and alarms might result in desensitisation and, over time, a diminished response to warnings and alerts.

2.3.2 Training for RSCs also did not address the issue of a Null ID indication, and there was no operating procedure to guide RSCs to resolve such an indication issue. There had been reports of Null ID indications made by operations staff to supervisors in the past, but the issue was not resolved. This might have reinforced RSC's belief that warnings associated with Null ID were false warnings and did not warrant any follow-up actions.

2.3.3 Following the incident, the rail operator, with the assistance of the Hotbox manufacturer, has rectified the Null ID indication issue and all trains are now consistently identifiable.

2.3.4 Nevertheless, the TSIB investigation team opines that the rail operator's prevailing procedures at the time of the incident for resolving issues relating to the Hotbox system could have been more robust. The rail operator should ensure that reported issues are followed through. The TSIB investigation team also opines that, if it had been made known to RSCs that warnings associated with Null ID should not be regarded as false warnings, the train would likely have been withdrawn to the depot earlier.

2.4 Detection of axle box temperature

2.4.1 Currently, the axle box temperature on trains along EWL is measured only once during each train's EWL's round trip of about two hours. The TSIB investigation team believes that early detection of abnormal axle box temperatures, as well as trend monitoring over time, can be enhanced by increasing the frequency of temperature measurement. This can be achieved through deploying more temperature sensors and leveraging on modern technologies. Enhanced monitoring would support early detection and proactive maintenance measures.

2.5 Industry cooperation

2.5.1 The rail operator is a member of an international grouping of metro operators which was formed for the sharing of operational and developmental best practices. The TSIB investigation team is encouraged by the rail operator's vision for closer collaboration and deeper engagement among the rail operator, the rail authority and train manufacturers. Such collaboration could promote open and constructive dialogue, raise awareness of potential failure modes and support the implementation of preventive measures. Strengthening cooperation across the rail industry will help align the stakeholders' long-term goals in safety, reliability and sustainability and will ultimately benefit the local rail network.

2.5.2 The TSIB investigation team understands that in the rail industry, train manufacturers are generally not obligated to inform rail operators or authorities about technical or safety issues once the trains have been delivered. Perhaps the rail industry can take cue from other industries where there is close cooperation in information sharing among the authorities, manufacturers and operators.

3 CONCLUSIONS

From the information gathered, the following findings are made. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

3.1 Axle box 19 had failed. This failure led to the four wheels from Car 2065's front bogie coming off the rail. Axle box 19 had probably experienced bearing seizure or undetected deterioration of its chevron springs. Both axle box 19 and its chevron springs experienced high heat as a result. Despite extensive testing and examination of axle box 19 and chevron spring debris, the TSIB could not determine the cause of axle box 19's failure owing to the severity of damage to axle box 19 and its chevron springs.

3.2 Up to the time of the incident, the rail operator's experience was that the axle boxes had been problem-free when its trains were being overhauled at 500,000 km. However, when the overhaul interval was stretched beyond 500,000 km, the quality of the axle boxes and chevron springs, as well as their components, were no more assured.

3.3 The rail authority was not involved in the waiver approval system of the rail operator and did not review any proposed extensions to overhaul intervals by the rail operator.

3.4 The rail operator's prevailing procedures at the time of the incident for resolving issues relating to the Hotbox system was not robust enough. There had been reports of Null ID indication issues before the incident but the issue was not resolved. The training for operational staff did not address Null ID indication. Operational staff had been treating warnings associated with Null ID as false warnings. Operational staff could have been desensitised, resulting in diminished response to warnings and alerts over time. Had it been made known to RSCs that warnings associated with Null ID should not be regarded as false warnings, the incident might have been prevented as the train would likely have been withdrawn to the depot earlier.

3.5 While the lack of records on maintenance decisions may not have directly contributed to the incident, the importance of ensuring that the records of decisions or evaluations made in an organisation’s operations are documented cannot be over-emphasised.

4 SAFETY ACTIONS

Arising from discussions with the TSIB investigation team, the organisation(s) has/have taken the following safety action.

4.1 The rail operator overhauled all the axle boxes of the fleet of trains to which T310 belonged that had exceeded 500,000 km mileage before they were allowed to return to service. The overhaul was completed by 13 October 2024.

4.2 The rail operator, with the assistance from the Hotbox manufacturer, rectified the Null ID indication issue. It has also required the MEC to share Level 1 warnings with the OCC via WhatsApp so that the OCC can take follow-up action if the RSC at the MEC misses the warning.

4.3 The rail operator has developed a procedure to require its staff to report to supervisors any Hotbox system defects and abnormal situations and to require such reports to be retained and addressed.

4.4 The rail operator is enhancing the waiver approval process by July 2025. The enhancement will mandate documenting the justifications for overhaul interval extensions.

4.5 The rail authority and rail operator plan to have more trackside infrared sensors to enhance the Hotbox system's capability in detecting hot axle boxes.

4.6 The rail authority now requires rail operators to inform the rail authority of extensions to overhaul intervals. The rail authority will audit to assess the completeness of the rail operators' engineering assessment and the appropriateness of any mitigating measures implemented, such as operational adjustments, enhanced monitoring and increased maintenance.

5 SAFETY RECOMMENDATIONS

A safety recommendation is for the purpose of preventive action and shall in no case create a presumption of blame or liability.

In view of the safety actions taken by the rail operator and rail authority, the investigation team did not have any safety recommendation to propose.